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EXPERIMENTS IN THE TREATMENT OF PLANT DISEASES.

By B. T. GALLOWAY and D. G. FAIRCHILD.

PART II.

TREATMENT OF PEAR LEAF-BLIGHT AND SCAB IN THE ORCHARD.

Dr. W. S. Maxwell's orchard, where these experiments were conducted, is situated near Still Pond, Maryland, in a region known as the Eastern Shore. This region is justly celebrated for its abundant yields of fruit, pears in particular being one of the most profitable crops. Of late years, however, this fruit has suffered greatly from the attacks of two diseases commonly known as leaf-blight and scab. These maladies are not confined to the Eastern Shore. On the contrary, we find them causing more or less damage wherever the pear is grown, so that these remarks are in a measure applicable to the whole country.

The leaf-blight and scab are caused by two very different species of fungi, which have received the rather formidable names of *Entomosporium maculatum*, Lév., and *Fusicladium pirinum*, (Lib.) Fckl., respectively.

The Entomosporium has already been made the subject of some investigations by this Division,* but no work in the line of preventing the injuries of the Fusicladium have, previous to this year, been undertaken. Dr. Maxwell being a heavy loser every season from both the diseases, and having placed his extensive orchards at our disposal, it was decided to carry on the work at his place.

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* Circular No. 8, 1889; Bulletin No. 11, 1889.

PEAR LEAF-BLIGHT.*

In the work on this disease an effort was made to throw some light upon the following questions:

I. The relative value, as preventives of the disease, of the Bordeaux mixture, the ammoniacal solution, mixture No. 5,† copper carbonate in suspension, and copper acetate.

II. The number of treatments necessary to obtain the best results at the least expense.

III. The relative value of early and late sprayings.

IV. Cost of each treatment.

The orchard chosen for the work consisted of Bartlett standards, Bartlett dwarfs and Duchess dwarfs, all of which were last year early defoliated by the leaf blight.

Following is a detailed account of the work taken from our field notes:

1. BORDEAUX MIXTURE.—*One treatment to two adjacent rows of* 54 *Bartlett standards.*—The treatment was made May 29, after the foliage was already partially diseased, numerous patches of the fungus being plainly visible on many of the leaves. Forty-four gallons of the mixture were used, costing 92 cents, or 1.7 cents per tree. The labor of preparing and applying was 60 cents, or 1.1 cent per tree, considerably less than in the experiments on a smaller scale.

Results.—The difference between the sprayed and unsprayed rows was very great, the latter appearing almost entirely bare on September 24, while the former were still in full leaf. Had the appliances at hand permitted the topmost branches to be sprayed thoroughly the difference would have been still more striking. It may be well to add here that for the entire work we used a Nixon Little Giant machine provided with 16 feet of hose and a Vermorel nozzle. Two men were required to work this apparatus, one to do the pumping and move the machine from tree to tree, the other to handle the nozzle. The machine did its work quickly and efficiently as is shown by the very small cost of the treatment.

The apparatus as it was used cost somewhere in the neighborhood of $40. We are satisfied, however, that a machine fully as efficient could be constructed by any intelligent person for less than half the above sum. Such a machine, made by us the past season and used in treating nursery stock, consists of a small force pump fastened to a barrel, the latter in turn being seated upon a sled which is drawn by a horse or mule. The machine, provided with 14 feet of hose and a Vermorel nozzle, can be made for about $18. This apparatus requires a horse, a man, and a boy to work it, and while it is an easy matter to spray as rapidly with it as with the Little Giant, experience has shown that in the end it is more expensive on account of the extra labor involved in working it. A machine to be drawn by hand can readily be made, the materials required being a two-wheeled truck, a barrel, a force pump, hose, and Vermorel spraying nozzle. Such an apparatus can be constructed for $14 or $15. The nozzle is provided with a three-fourth inch screw attachment, and instead of the old style degorger we now fit them with the same kind in use on our lance.*

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* *Entomosporium maculatum*, Lév. For an account of the life history of this fungus see Annual Report of the Commissioner of Agriculture, 1888, p. 357.

† Composed of equal parts of ammoniated copper sulphate and sodium carbonate.

Returning again to a discussion of the experiments:

II. BORDEAUX MIXTURE.—*Three early treatments to five trees of Bartlett dwarfs.*—The sprayings were made on May 5, 16, and 28, sixteen gallons of the mixture being used. It required 35 minutes to do the spraying, and, estimating the labor at $1.50 per day, the cost of it is 17 cents, or 3.4 cents per tree. The cost of the material was 34.7 cents, or 6.93 cents per tree, making the total expense of treating each tree three times, 10.33 cents.

Results.—On October 6 the treated trees were in nearly perfect foliage while the untreated in adjacent rows had dropped most of their leaves.

III. BORDEAUX MIXTURE.—*Three late treatments to five Duchess dwarfs.*—The dates of treatment in this case were May 28, June 23, and July 8. Sixteen and eight-tenths gallons of the mixture, costing 35 cents, were used. The expense for labor was 24 cents, making the total cost of the sprayings 11.8 cents per tree.

Results.—On October 6 the trees still retained a large part of their foliage while the untreated had lost every leaf.

IV. BORDEAUX MIXTURE.—*Six treatments to five Bartlett dwarfs.*—The treatments were made on May 5, 16, and 28, June 10, 23, and July 8. Thirty-six gallons of the mixture were used and 87 minutes were required to do the work, making the cost for the mixture 15.1 cents per tree and the labor 8.7 cents, a total of 23.8 cents per tree.

Results.—The foliage was completely preserved up to the time the frost removed it. It was, however, in no better condition than that in experiments II and III.

V. AMMONIACAL SOLUTION.—*One treatment to two rows of Bartlett standards containing* 54 *trees.*—The treatments in this and the following experiments were made on the same dates as I, II, III, and IV; moreover, all the other conditions were practically the same. Forty-four gallons of the solution, costing 33 cents, were used. The cost of labor in preparing and applying was 45 cents, making the total cost 78 cents, or 1.44 cent per tree.

Results.—The foliage on September 24 was not as well preserved as that of I, but it was much more perfect than that on the untreated trees. On October 8 the leaves had nearly all fallen.

VI. AMMONIACAL SOLUTION.—*Three early treatments to five Bartlett dwarfs.*—Treatments made on the same day as II, 22 gallons of the solution costing 16.6 cents being used. The expense of application was 28 cents, making a total of 44.6 cents, or 8.92 cents per tree.

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* Illustrated in Vol. VI, No. 2, 1890.

Results.—On October 8 the treated trees were in good foliage, while the adjacent untreated trees were leafless.

VII. AMMONIACAL SOLUTION.—*Five late treatments to twelve Duchess dwarfs.*—Treatments made May 28, June 10, and 23, July 8 and 19, 58 gallons of the liquid costing 43.5 cents being used. The cost of labor was 42.5 cents, making a total of 86 cents or practically 7 cents per tree.

Results.—On September 24, the foliage was only partially removed by the disease and the contrast, though not striking was quite apparent. On October 8 the contrast was much more marked.

VIII. AMMONIACAL SOLUTION.—*Six treatments to three trees of Bartlett dwarfs and four of Bartlett standards.*—Dates of treatments as in IV, 67 gallons being used at a cost of 50.2 cents. The cost of application was 58 cents, making a total of $1.08, or 15.4 cents per tree.

Results.—The standards showed the effects earliest and most markedly, but both held their foliage well into October while surrounding unsprayed trees dropped their leaves before the last of August.

IX. MIXTURE NO. 5.—*Six treatments to five trees of Bartlett dwarfs.*—Applications made the same as in IV, 36 gallons, costing 43 cents, being used. The cost of application was 45 cents, making the total expense 17.6 cents per tree.

Results.—The foliage was badly burned and many leaves dropped in consequence, but the leaf-blight was effectively prevented.

X. COPPER ACETATE.—*Three treatments to two Bartlett standards.*—The applications were made May 28, June 23, and July 8, using a solution of 3 ounces of the acetate to 6 gallons of water. Nine gallons of the mixture, costing 8.6 cents, were applied at an expense of 10 cents for spraying. The total cost therefore was 18.6 cents, or 9.3 cents per tree.

Results.—On October 6 the foliage was in a fair state of preservation, while adjacent untreated trees were leafless. No noticeable damage was done to the foliage, only an occasional leaf being injured.

XI. COPPER ACETATE.—*Six treatments to five trees of Bartlett dwarfs.*—Dates of treatment as in No. IV. Forty gallons of fluid were used, 4 gallons of a strong mixture (4 pounds to 22 gallons), and 36 of a modified (12 ounces in 24 gallons) solution, at a total cost of 62 cents, or 12.4 cents per tree. The cost of application amounted to 45 cents, or 9 cents per tree, making the total expense per tree 21.4 cents.

Results.—The leaves were severely injured, many of them falling long before the proper time. There is no doubt as to the fungicidal properties of this preparation; its use, however, can not at present be recommended.

XII. COPPER CARBONATE IN SUSPENSION.—*Six treatments to five trees of Bartlett dwarfs.*—The solution made by mixing 3 ounces of copper carbonate in 22 gallons of water was applied on the same dates as IV. Forty-three gallons of the solution were used, but after the first two applications, which seemed to have little effect, the strength was doubled. The total cost of the treatments with this preparation was 13.3 cents per tree.

Results.—The disease was in a measure prevented, but the difference between the treated and untreated trees was not worthy consideration.

SUMMARY OF RESULTS.

Before summing up the results it is proper to state that the season was one exceedingly unfavorable for such an experiment, as the disease even on the untreated trees did comparatively little damage. We feel warranted, however, in drawing the following conclusions from the work.

I. The relative value of the preparations used in treating leaf-blight stand in the order named:

Bordeaux mixture.
Ammoniacal solution.
Copper acetate (3 ounces to 6 gallons).
Mixture No. 5.
Copper carbonate in suspension.

The difference between the Bordeaux mixture and the ammoniacal solution is scarcely perceptible, and if the cost is considered the latter stands first.

II. The best results at the least expense were obtained by the *early* treatments. It is well to add here that we do not accept this evidence as conclusive; on the contrary, we are inclined to think that had the disease been severe three treatments would not have been sufficient to hold it in check.

III. Early sprayings are unquestionably better than late ones.

IV. The cost of the various treatments will, in a measure, depend on the kind of spraying apparatus used, the distance from places where chemicals may be obtained at wholesale rates, and skill of the operator. It may safely be put down that for orchards of one thousand or more dwarfs the cost for treating with the Bordeaux mixture need not exceed 2 cents per tree for each application. For standards the cost will reach 3 cents or perhaps a little less.

In treating with the ammoniacal solution, which is the only additional preparation worth considering in this connection, the cost for dwarfs will average in the neighborhood of 1½ cents per tree and for standards 2½ cents.

From one season's work it is of course impossible to draw any definite conclusions as regards the direct benefit to the trees resulting from the treatment. It is reasonable to assume, however, that if the leaves on a tree, and especially a fruit tree, can be made to continue their normal work until frost, they will enable the tree to make a better growth, set more fruit buds, and consequently bear more fruit the ensuing season than one which loses its foliage in midsummer. There is, however, a more important matter to consider in this connection, and that is the life of the tree itself. We know that in sections where the leaf-blight is severe a tree soon succumbs entirely to the disease. While we have no data bearing on the longevity of treated trees there is no room to doubt that they can at least be made to live their allotted time.

TREATMENT OF PEAR SCAB.*

These experiments were carried on in the same orchards and at the same time as those described in the preceding pages. Owing to the fact, however, that very little fruit set the work was far from satisfactory. At the time of the first treatment the fruit was about half an inch in diameter and stood erect upon the pedicels. The Bordeaux mixture, ammoniacal solution, mixture No. 5, copper carbonate in suspension, and acetate of copper were used, an effort being made in all cases to bring out, if possible, the relative value of the fungicides as preventives of the disease, the effect of early and late sprayings, the relative value of three and six treatments, and the cost of each application. Without going into the details of the work it may be said:

I. That in no case were the sprayings made early enough, as scab spots had already appeared on the fruit when the first applications were made. It was clearly evident that one spraying should have been made when the flowers were beginning to open and another when the fruit was about the size of peas.

II. There was no material difference so far as the amount of scab was concerned between the trees treated early and late and those which received three and six sprayings, respectively. By early here it must be borne in mind that we mean when the fruit was half an inch in diameter.

III. The costs of the treatments were found to be practically the same as those for pear leaf-blight. When one intends to spray for leaf-blight it will be an easy matter to begin earlier and treat the scab at the same time. In spraying for both of these diseases it would be well to make the first application as described above for scab, then follow with additional treatments at intervals of 12 or 15 days until six or seven in all have been made. In the present condition of our knowledge the Bordeaux mixture is the preparation most to be relied upon as effective against both leaf-blight and scab, and at the same time not injurious to the fruit. Should early treatments alone be made the case would be altered.

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* *Fusicladium pirinum*, (Lib.) Fckl.